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# ASSESSING STUDENTS IN SENIOR SCIENCE: AN ANALYSIS OF QUESTIONS IN CONTEXTUALISED CHEMISTRY EXAMS

Dr. Alberto Bellocchi

Queensland University of Technology

alberto.bellocchi@qut.edu.au

Dr. Donna King

Queensland University of Technology

d.king@qut.edu.au

Prof. Stephen Ritchie

Queensland University of Technology

s.ritchie@qut.edu.au

## Abstract

This study explores the development of a coding system for analysing test questions in two context-based chemistry exams. We describe our unique analytical procedures before contrasting the data from both tests. Our findings indicate that when a new curriculum is developed such as a context-based curriculum, teachers are required to combine the previously separate domains of context and concept to develop contextualised assessment. We argue that constructing contextualised assessment items requires teachers to view concepts and context as interconnected rather than as separate entities that may polarise scientific endeavour. Implications for practice, curriculum and assessment-development in context-based courses are proposed.

**Keywords:** *assessment, context-based, chemistry*

## INTRODUCTION

International research in chemistry education has received attention in recent years highlighting the attempts to improve student motivation and interest through context-based approaches (Barber, 2000; Bennett & Lubben, 2006; Gutwill-Wise, 2001; Hofstein, Kesner, & Ben-Zvi, 2000; Parchmann et al., 2006). More recently, research in Australia focussed on the teaching and learning in context-based chemistry courses highlighting the pedagogical approaches used by teachers and the connections students made between concepts and contexts (King, 2009; King, Bellocchi, & Ritchie, 2008). Despite a commitment to context-based teaching nationally and internationally, there is a lack of research addressing the assessment of context-based chemistry (King, 2009). This issue remains one of interest for curriculum writers and assessment designers given the intrinsic relationship between curriculum and assessment.

In this study, we investigate tests developed by teachers working within a context-based curricular approach. We integrate work by Ahmed and Pollitt (2007), and Cumming and Maxwell (1999) to analyse and interpret test-questions and suggest how to avoid potential pitfalls in assessment design. Additionally, we identify a series of factors that can influence the quality of contextual test-questions.

## LITERATURE REVIEW

### What are “Contexts” in Science Education

The notion of “contexts” has been used variably in educational practice and scholarship. The use of “context” in the ChemCom (American Chemical Society [ACS], 2001), Salters (University of York Science education group [UYSEG], 2000) and PLON (i.e., Physics Curriculum Development Project; Eijkelhof, & Kortland, 1988) curricular approaches refers to the “application of the chemistry to a real-world situation” as central to the teaching of chemistry. The chemistry is taught when the students require the knowledge for further understanding of real-world applications (Bennett, 2003). Such an instructional framework embodies a “need-to-know” principle: the context must legitimise the learning of chemical concepts from the perspective of the students and thus make their learning extrinsically and intrinsically meaningful (Beasley & Butler, 2002).

In this study, we investigated the test-questions developed by teachers at City School, an urban high school in Queensland (QLD), Australia. Curriculum in QLD is developed by an organisation known as the Queensland Studies Authority (QSA). The QSA develop curriculum documents known as syllabi (singular: syllabus), and these documents are then interpreted by teachers into school programs. The QSA defined “context” in the 2004 chemistry syllabus as follows:

Contexts are groups of related situations, phenomena, technological applications and social issues which are relevant and of interest to students and have the potential to support learning Chemistry principles, concepts and skills. Key concepts and key ideas must be embedded in real-world contexts. (QSA, 2004, p.11)

A key difference between this approach to contexts compared to that described by Bennett (2003) is that the “need-to-know” aspect of learning in context is not evident in the QSA statement. Three aspects of learning chemistry in a contextual approach are identifiable in this statement. The first aspect is that the definition assumes that concepts and contexts are separate constructs: thereby establishing a dichotomy. In this study, we make the argument that this splitting of concepts and contexts leads to a false dichotomy (Bohm, 1994). The second aspect is that teachers are expected to unite these in meaningful ways for students during instruction and assessment. Given that the terms concept and context were used in the syllabus and by teachers, we adopt this terminology throughout the paper for convenience although we do not advocate simplistic use of such categories in our conclusions. The third aspect is that there are two reasons for using contexts. One reason is to generate student interest in the science, for example, through use of technological applications, and societal issues. The second reason is for contexts to act as vehicles for making meaning of concepts.

### Context-Based Assessment

Brown, Collins and Duguid (1989) identified that school-based assessment tends to reflect the decontextualized nature of school learning rather than the work of practitioners in a field of study (e.g., science). This, they assert, leads to success in school that bears little significance in the culture of the field of study. Context-based assessment stands in contrast to this as its aim is to provide authentic problems for students to engage with. In relation to authentic

assessment, contexts refer to the ability to use knowledge in situations that require it. For example, Wiggins (1993) explained contexts as follows:

[A context is]... realistic to the extent that we so accept the premises, constraints, and "feel" of the challenge that our desire to master it makes us lose sight of any contrivances or extrinsic factors - factors such as the reality that someone is evaluating us.... (p.211)

In their review of context-based and science, technology and society (STS) approaches of the impacts on student achievement, Bennett, Lubben and Hogarth (2007) found that "[p]erformance on assessment items is linked to the nature of the items used, i.e. students following context-based/STS courses perform better on context-based questions than on more conventional questions" (pp. 362-363). Furthermore, they reported that only when teaching approaches departed from traditional forms of instruction did students' conceptual understanding benefit from a context-based approach.

### **Contextual Test Questions**

Associated with the definition of context and for the purposes of our study, we differentiate between contextual test-questions and conceptual test-questions. Contextual test questions are those that specify the application of science concepts to a "real-world" scenario (Ahmed & Pollitt, 2007); that is, relevant to student interest or to applications of science by experts. In this usage, "contextual" refers to any attempt, authentic or contrived, to link science concepts and contexts in a test question. Conceptual test questions are those that require the use of scientific principles, algorithms, and concepts without relating these to real-world scenarios. Examples of each question type are provided in our analyses.

Ahmed and Pollitt (2007) cite three reasons for using contextual test-questions. The first reason is that if we do not, we risk questions requiring the mere recall of information. This can reduce learning science to learning information from books and regurgitating it in a test. The second reason is that contextual questions can be more concrete and be less demanding. The third reason is that contextual questions are relevant to students' lives. Ahmed and Pollitt (2007) assert that contexts, in well-constructed questions, can assess a students' ability to apply their understanding of concepts. However, poorly contextualised questions can "prevent us from measuring anything at all" (p. 203).

Ahmed and Pollitt (2007) conducted a study into the effects of contextual test questions in PISA science tests on student responses. Specifically, they manipulated test questions to generate what they called more *focussed* questions and less focussed questions. Focus refers to the extent to which a context in a question provokes the same schemas in students' minds as the science or mathematics concepts in the question. More focussed questions, they assert, will help activate relevant concepts rather than interfere with reasoning and comprehension.

These researchers found that in every case where they changed a contextual question to a more focused one, the question item was improved in relation to the students' abilities to respond appropriately to the item. They asserted that real world contexts can activate everyday knowledge, or schemas, that interfere with the science schemas activated by the question.

An earlier study by Cumming and Maxwell (1999) addressed the issue of contextual assessment in relation to its authenticity (Wiggins, 1993). They identified two theoretical considerations in relation to assessment. As with Ahmed and Pollitt (2007), Cumming and Maxwell (1999) firstly draw attention to validity of assessment and secondly to the contextual nature of assessment. Cumming and Maxwell (1999) suggest that attempts to make assessment authentic can lead to 'dressing up' traditional forms of assessment to look like truly contextual tasks. They refer to such contrived items as being *camouflaged*. They offer the following as an example of a camouflaged mathematical question:

Toula and Roula each buy a new book. Toula's book has 450 pages and Roula's book has 280 pages. If Toula reads 50 pages per day and Roula reads 40 pages per day, who will finish their book first? (Cumming & Maxwell, 1999, p. 188)

Cumming and Maxwell (1999) argue that the familiar Australian television characters, Toula and Roula, do not contextualise the problem or create a degree of situatedness that could facilitate a solution. Such camouflage could serve to confuse and may be an example of an unfocused question in Ahmed and Pollitt's scheme.

As Ahmed and Pollitt (2007) and Cumming and Maxwell (1999) suggest a cautionary note must be made that in developing curriculum and assessment in context, care is needed to ensure the

context provides strong focus for learning genuine applications of science and does not lead to camouflage and distraction.

The use of contextual test-questions is a widespread practice internationally, although there has been little research conducted on the implications of context-based assessment on teachers' practices and student learning (Ahmed & Pollitt, 2007). Few studies have investigated the quality of contextualised questions. Contextualised questions are found in tests and textbooks regardless of whether a context-based approach to curriculum is adopted. Ahmed and Pollitt (2007) have suggested that students face specific problems when presented with poorly contextualised test-questions. Another issue identified by Cumming and Maxwell (1999) is that teachers can "dress up" traditional assessment items to make them appear contextual. This can lead to questions becoming verbose, providing distractions to students from what the question is requiring them to do.

## **RESEARCH DESIGN**

### **Purpose of study**

The purpose of this study was to analyse contextual test-questions developed by teachers at City School in Queensland, Australia as part of a context-based curriculum. Specifically we investigated what factors may determine whether contextual questions are focused or camouflaged.

### **DATA SOURCES**

The data sources for this study consisted of tests developed by teachers at City School during the implementation of a new context-based curriculum based on the Queensland Extended-Trial Pilot Chemistry Syllabus (Queensland Studies Authority, QSA, 2004). The assessment items we studied were end of semester tests (labelled EOS1 & EOS2) administered once in June, and once in September. These tests were high-stakes assessments (Harlen, 2005) as they were used in determining student levels of achievement that are used to calculate their tertiary entry options as well as being reported on student report cards. The tests involved a combination of written answer questions (non-calculation based questions) and mathematical questions (calculation based).

There were three-Year 12 chemistry teachers involved in the development of tests at the time of this study. At City School, for each assessment item there was a designated assessment writer and an auditor. Assessment items were also distributed to the third chemistry teacher for comment. Alberto, one of the researchers in this study, was the co-author of the End of Semester 2 (EOS 2) test and an auditor for the End of Semester 1 (EOS1) test. The roles of the writer, auditor and third party were not always clearly defined. Auditors and third parties sometimes provided questions or suggested modifications to questions to assist the writer. However, tests were chiefly the writer's work. Another common practice in preparing tests was the use of questions designed by the teachers and those from publicly available sources (e.g., from internet sources of past state, national and international tests). The tests were both based on a criterion-referenced system. The QSA provided criteria and standards to inform design of all assessment instruments used in QLD schools.

## **DATA ANALYSIS**

### **Analysis of Tests**

Three layers of data analysis were used to interpret each test question in the two tests (i.e., EOS1 & EOS2).

#### **Layer 1- Identifying Focused and Camouflaged Contextual Questions**

The first layer of analysis involved coding the test based on the type of question. Three categories were developed to code for the question type: 1) Conceptual (CO), 2) Focused (F; contextual), and 3) Camouflaged (CG; contextual). The conceptual question category (CO) referred to questions that contained no links to the real-world applications of chemical concepts. For example, "How much acetic anhydride is required to react completely with 20g of salicylic acid?"

We synthesised the works of Ahmed and Pollitt (2007) and Cumming and Maxwell (1999) to develop the analytical categories called *focus* (F) and *camouflage* (CG) for coding contextual questions. According to Ahmed and Pollitt (2007), focus refers to the extent to which the context in a question requires a scientifically conceptual response. For example,

Question: The first location visited on a field study along Pete Creek was near a shipping port. The table below [not presented here] presents a range of water quality parameters for the site. Systematically analyse the data in the table and provide a justification for the observed patterns in water quality parameters.

To answer this question, one is required to consider the real-world factors that can affect Pete Creek (i.e., the effects of the port on the contents of the water) and apply an understanding of factors that affect water quality (i.e., concepts of pH, salinity etc.) to arrive at a reasoned conclusion. The location at site 1 of the creek could provide important contextual clues as to what factors may be impacting on pH and salinity. For instance, if students had attended a field excursion to the creek they may have noted particular land-uses around site 1 that could affect pH or DO.

Camouflage refers to questions that provide a context that merely disguises a conceptual question. For example,

Question: Calculate the pOH of a sample of saliva where the hydrogen ion concentration is 1M.

It is irrelevant to refer to saliva in asking or responding to this question because all that is required is the calculation. That is, the application of the pH concept. Questions such as this could simply be asked as follows:

Question: Calculate the pOH of a solution where the hydrogen ion concentration is 1M.

### **Layer 2- Comparison of Focused and Camouflaged Questions With Question Standards and Criteria**

The second layer of analysis involved a comparison of the coding of focus and camouflage (from Layer 1) with standards assigned to each question in the tests by the teachers. The teachers used the syllabus criteria associated with each of five standards of achievement (i.e., VHA, HA, SA, LA, VLA) to design questions that targeted each criterion and standard.

The two criteria were Knowledge and Conceptual Understanding (KCU) and Scientific Investigation (SI). The following elaboration of KCU was provided in the syllabus:

Students should acquire knowledge and construct understanding of facts, theories, concepts and principles of chemistry. They should use these understandings to engage with real-world contexts involving scientific, technological and social issues. (QSA, 2004, p. 9)

The SI criterion was elaborated as follows: Students should develop and use ideas, skills and techniques to perform experimental and non-experimental investigations. They should explore questions and issues individually and with others and present chemistry information in a variety of modes. (QSA, 2004, p. 9)

For the purpose of determining student levels of achievement in the two tests. Each criterion was elaborated into the five standards (i.e., VHA, HA, SA, LA, VLA) with written descriptors explaining typical demonstration for each standard.

The VHA stands for very high achievement and is the highest level of achievement awarded, while VLA stands for very low achievement and is the lowest level awarded. For instance, using their knowledge of what students had studied in class, the teachers wrote questions that required recall of learned facts and assigned these a maximum of a Sound Achievement (SA) standard. On such a question a student response was graded as either correct, therefore achieving the SA standard, or one of LA or VLA (i.e., the lowest level of achievement) depending on the quality of response. Questions that required application of facts or concepts in solving a novel problem were assigned a high achievement (HA) standard within the Knowledge and Conceptual Understanding criterion. For example, the question presented earlier relating to pOH would be rated at an SA standard as it required application of basic concepts rehearsed in class. In reporting our analyses, we adopted these question-categories (i.e., VHA, HA, SA) to describe the questions in the tests. This practice of assigning questions with specific levels of achievement was situated within the City School context and we cannot make claims in relation to how widespread this practice is internationally. Thus, we were able to identify any relationships with the difficulty of a question (identified by its VHA, HA, SA coding) and the Layer 1 coding.

### **Layer 3- Comparison of Focused and Camouflaged Questions With Calculation or Written Response Question Requirements**

The third layer of analysis involved comparison of Layer 1 categories with questions requiring mathematical calculations (calculation based, CB) and those that required written responses without calculations (non-calculation based, NCB).

For each layer of analysis, we categorised the assessment items independently and then compared our analyses. The process was repeated until we arrived at consensus on the categorisation of the questions. In the analysis of tests, each part of a question was counted as an individual question. For example, if question 1 in a test had parts a), b), and c), then these three parts were counted as three individual questions and analysed through the four layers of analysis. We report the percentages and frequencies for questions in each of our coding categories.

Alberto also provided additional information and explanation of how the tests were designed and through his emic perspective we reconstructed some of the factors that influenced the types of questions in the tests.

## RESULTS

The key findings of our study were:

- 1) Most camouflaged questions were recall and simple application questions in the knowledge criterion
- 2) There were no scientific investigation questions that were camouflaged
- 3) Most focused questions were interpretation or complex and challenging questions in the knowledge criterion

We report the warrants for these three findings based on each layer of analysis followed by a summary of the cross-analysis of the three layers. Appendix A presents a summary table of all data analysis. The tables used in the sections that follow were derived from the summary table.

### Layer 1- Focused and Camouflaged Questions

Twenty five contextual questions out of a total of 44 questions were identified in the 2 tests. Of the 25 questions, there were 15 focused questions and 10 camouflaged questions (See Table 1).

**Table 1** Number of Focused and Camouflaged questions in two tests (EOS 1 & EOS2)

Contextual Question Types	EOS 1	EOS 2
CG	9	1
F	8	7

NB: F- focused, CG- camouflaged, EOS1- end of semester 1 test, EOS2- end of semester 2 test

### Layer 2- Comparison of Focused and Camouflaged Questions With Question Standards and Criteria

Most of the focussed questions were VHA and HA standard questions (Table 2) while Ass standard were the most camouflaged questions. All camouflaged questions were KCU and there were no camouflaged SI questions.

**Table 2** Number of Focused and Camouflaged Questions in Each Criterion and Question Standard

Contextual question types	Criteria					
	KCU			SI		
	VHA	HA	SA	VHA	HA	SA
CG	1	1	8	0	0	0
F	7	2	3	0	3	0

NB: KCU- knowledge and conceptual understanding, SI- scientific investigation, VHA- very high achievement, HA- high achievement, SA- satisfactory achievement

Thus, the occurrence of camouflaged questions coincides only with the knowledge criterion. The common requirement of the questions in this criterion was the recall of knowledge or application of rehearsed skills. For example, two questions required the application of the pH concept to solving a mathematical calculation. Another question involved the use of Le Chatelier's principle to predict the effects of different stimuli on an equilibrium system.

Alberto suggested that as author of one of the SA camouflaged questions, he had simply dressed it up to look contextual. Such dressing up was consistent with the concept of camouflaged questions developed by Cumming and Maxwell (1999).

The elements of the QSA chemistry syllabus for the SI criterion relevant to the two tests required students to demonstrate the following characteristics:

- discovering relationships and patterns, characteristics and anomalies in data and information;
- analysing and modelling data, extrapolating and making predictions, proposing solutions and supporting decisions;

The questions in the two tests required students to perform a number of these processes in their responses.

### **Layer 3- Comparison of Focused and Camouflaged Questions With Calculation or Written Response Question Requirements**

There were more non-calculation based questions that were camouflaged than calculation-based questions (see Table 3).

**Table 3** Number of Focused and Camouflaged Calculation-Based Questions and Non-calculation Based Questions

<b>Contextual Question Types</b>	<b>CB</b>	<b>NCB</b>
<b>CG</b>	3	7
<b>F</b>	3	12

NB: CB- mathematical calculation questions, NCB- written response questions

However, the largest frequency of contextual questions were the non-calculation based, focused questions.

### **Summary- Cross-Analysis of Layers 1, 2, and 3**

The results indicated that NCB, SA standard questions in the KCU criterion were the most frequently camouflaged questions across the two tests, while CB, VHA standard questions in the KCU criterion were the most frequently focused questions. Given that, the KCU criterion was common to both focused and camouflaged questions; it was unlikely to be the most significant factor in determining the focus of the question. Thus, the unique feature that is most frequently displayed by camouflaged questions is the SA standard.

Upon analysis of the syllabus criteria used by teachers to design questions, we identified that the SA standard was defined as follows:

[The student]...Consistently recalls, defines and explains a range of ideas and concepts....  
(EOS 1 Test)

or,

The student who applies knowledge and understanding in societal and scientific situations: applies algorithms concepts, principles and schema to problems solving and predicting outcomes. (QSA, 2004, p. 35)

All SA ranked questions involved skills relating to recall or application of information.

In contrast, the Very High Achievement (VHA) ranked questions were based on standards such as:

[The student]...Consistently adapts, translates and reconstructs understandings of...  
[concepts]...to...[answer the question]. (EOS 1 test)

High Achievement (HA) ranked questions addressed the following criterion:

The student who develops knowledge and understanding: Adapts and translates understanding of concepts, theories and principles. (QSA, 2004, p. 35)

The key differences between the standards appear to be between the “recall and application of concepts” in the SA standard, moving to “adaptation and translation of concepts” in the HA standard. The difference between a VHA and HA standard for the criterion described above was the inclusion of the term “reconstructs” in the VHA standard in addition to the terms “adapts and translates” that were present in the HA standard (See Appendix A for the Exit level of Achievement developed by the QSA). While the more recent version of the syllabus (QSA, 2007) contains slightly different terminology for the criteria, the essence of their structure is similar to that used in the Trial-Pilot syllabus of 2004 (See Appendix B).



The common factor to all camouflaged questions was that if the context in the question was removed, the essence of what students were being asked to do did not change. This was irrespective of the standard or criteria at which the camouflaged question was targeted. The contextual questions that required students to adapt and translate their understanding of concepts to answer the question were more focussed.

### **Conclusions**

We present three assertions to summarise our findings:

- 1) Most camouflaged questions were recall and simple application questions in the knowledge criterion
- 2) There were no SI questions that were camouflaged
- 3) The most focused questions were interpretation or complex and challenging questions in the knowledge criterion

#### **Assertion 1- Most camouflaged questions were recall and simple application questions in the knowledge criterion**

Analysis of the criteria and associated standards from the syllabus that teachers in this study used to design questions indicated that SA questions involved simple recall and application of chemical concepts. This was the only unique factor we analysed shared by the majority of camouflaged questions. Interviews with Alberto provided insights into a possible explanation of this finding. He indicated that in the case of one question that he had written, that the context was an “add-on” to the question to make it look contextual. It was not possible to ascertain whether the other SA standard questions were camouflaged for this reason.

#### **Assertion 2- There were no SI questions that were camouflaged**

The SI criterion requires that students interpret data, evaluate data, and reach justified conclusions about data and investigations. It is possible that due to these requirements, teachers were forced into considering data and investigations that were contextually focused and thereby leading to only focused question being generated for this criterion.

#### **Assertion 3- The most focused questions were interpretation or complex and challenging questions in the knowledge criterion**

The knowledge criterion for the VHA and HA standards required that students engage with complex and challenging scenarios and interpret chemistry concepts to arrive at reasoned solutions to the questions. Alberto reported that in contrast to the SA questions, teachers spent more time in developing and phrasing the VHA and HA questions. This could be one reason why these were the most focused questions across the two tests.

### **Implications for Theory**

One of the obvious things wrong with thought is *fragmentation*. Thought is breaking things up into bits which should not be broken up. (Bohm, 1994, p. 3)

Thus we have false division and false unification. (Bohm, 1994, p. 4)

The creation of bordered entities such as concepts and contexts should seem surprising in the social sciences. Particularly in relation to science education; given that our understanding of physical matter informs us that it is mainly empty space. One wonders then how ideas, which surely are less concrete than matter, can be perceived as bordered entities. Surely, they are more porous than matter itself! Those lines of demarcation that we draw between concepts and contexts must at best be dotted lines as Bohm (1994) suggests. This is pertinent when theorising and developing curriculum as the outcomes that stem from our assumptions and categories can lead to problematic situations such as the development of camouflaged questions as reported in this study. Categories are useful ways of organising our world, but losing sight of their origins can lead to binary ways of thinking that in practice do not reflect things as they are. We suggest that designers of assessment tasks view concepts and contexts as interconnected. In such a way, when test writers create contextual questions, concepts and context cannot be viewed separately. Rather, it is best to ask, “How can this problem be solved through science?” Doing so will ensure that the starting point for the question is not the concepts one wishes to elicit from a student, rather, the starting point is the real-world phenomenon. The concepts become possible solutions to the problem. We propose the interconnection of concept and context be used as a threshold idea to capture the useful categories into which we have organised our curriculum, but reunites these porous categories and highlights that they are inextricably linked.

We may *distinguish* certain things for the sake of convenience. The word 'distinguish' means 'to mark apart.' A distinction is merely a mark which is made for convenience; it doesn't mean that the thing is broken. It's like a dotted line, whereas when we represent something as divided it's a solid line. (Bohm, 1994, p. 72)

A more focussed study is required into student responses to similar test items, where conceptual questions and contextual questions appear, to determine whether there is any effect on student responses and the extent of any of these effects.

We are also exploring the possibility of using our tentative model for coding and evaluating contextualised test-questions in the interpretation and analysis of other contextualised assessment types such as EEs (investigations and associated reports) and ERTs (e.g., essays, extended writing tasks).

This study contributes to the literature and research on assessment in three ways. First, it adds to Ahmed and Pollitt's (2007) work by investigating the nature of contextual questions in tests designed for high school students. The application of Ahmed and Pollitt's (2007) work in science education is also unique. Second, it provides comparisons of the focused or camouflaged questions with factors such as the criteria the questions were written to address and the standards for meeting these criteria. Third, it provides an in-depth study of test design in a context-based curricular approach.

### **Implications for Teaching and Test Question Design**

Earlier in the paper, we provided the example of the camouflaged question relating to the pOH of saliva. We established this as an example of a camouflaged question because the context of the human body (alluded to by reference to saliva) was irrelevant to solving the problem. We now offer a contextualised version of the same question to suggest how teachers can modify these questions to make them focussed. For example,

Question: A patient is having problems with ingesting their medication. The medication comes in the form of a capsule whose casing will dissolve in normal saliva pH (6.2-7.4). The patient's saliva was tested and found to contain a hydroxide ion concentration of 1M. Offer a justified explanation for the patient's problem with ingestion of the capsule.

In this question, the context of the saliva is necessary in establishing whether the pH of the patient's saliva is the reason why they cannot ingest the capsules. That is, chemistry provides the answer to this contextual problem. We acknowledge that in our study the majority of camouflaged questions were those rated SA. The question relating to medications above requires some interpretation in order to answer it correctly. Thus, this may elevate the rating of the question to a HA standard. Care must be taken in schools that adopt a similar approach to assessment as the school in this study. If questions are written in more focussed ways, the level of difficulty of the question may be increased. The teachers in this study found that students who achieved SA standards on their assessment tasks, were unable to make a start at answering the VHA standard questions. Typically, they expected that students could achieve SA standards on VHA questions as was common with past assessment practices in the school.

Curriculum writers of the past saw it fit to identify those products of science we commonly accept as concepts and use them to structure pedagogy. Concepts were then used as starting points for the induction of learners into the scientific world-view and discipline areas. In creating this distinction called "concept", we have created solid demarcation lines splitting and divorcing these scientific products from their source: the investigation of our world, the context.

Thus, it makes sense now to ask teachers to unify these arbitrary categories, these discourses, of concept and context to fabricate situations where the merging of these two discourses is valued and promoted. In assessment we have seen that the artful merging of context and concept can lead to challenging, focused contextual questions. However, it may also lead to camouflage and this is potentially detrimental to student achievement. In the high-stakes, assessment-driven culture of high school it pays to get it right. We question, however, how teachers are to get it right. Who informs the question writing process so that contextualised questions are focussed and not camouflaged? How are teachers expected to achieve this when they may not be experts in the contexts they have been asked to integrate into their lessons or unify with concepts? What implications does this have for teacher preparation and professional development?

We suggest that appropriate professional development relating to assessment must accompany any new development. Teachers from City School achieved this partly by contacting community

members from the chemical industry and used their discussions as starting points for developing accurate real-world contexts for their units of work and assessment items.

**Decision Making Key for designing contextually focussed test questions to check for focus and camouflage:**

- 1) Do you want to test conceptual understanding (CO) or an application of a concept to a real-world situation (CM)? CO- Question 2; CM- Question 3
- 2) CO question best written with no context
- 3) CM question- Does the context in the question require a scientific solution to a problem? Yes- Then question is focussed (F); No- Question is Camouflaged (CG).
- 4) Write a model response. Does the model response contain links between the context and concept? If no, proceed to Q5.
- 5) Question is potentially camouflaged return to Question 1 and reconsider the need for a context in the question.

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**APPENDIX A**  
**Data Summary Table**

Contextual question types	Criteria	KCU		
	Ratings	A	B	C
CG	CB	0	1	2
	NCB	1	0	6
F	CB	3	0	0
	NCB	4	2	3

SI		
A	B	C
0	0	0
0	0	0
0	0	0
0	3	0